DOCUMENT RESUME

ED 418 857 SE 061 331

AUTHOR Morrell, Patricia D.; Andrews, Gail Glick
TITLE Factors Affecting Undergraduate Women's Consideration of Graduate Study in Science.
PUB DATE 1998-04-00
NOTE 18p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (71st, San Diego, CA, April 19-22, 1998).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Career Choice; Educational Experience; Females; *Graduate Study; Higher Education; Majors (Students); *Science Education; *Student Attitudes; *Undergraduate Study

ABSTRACT

This study focused on female undergraduate students considering graduate study in the sciences in an attempt to identify their critical attitudes and concerns. Of particular interest were the factors that women felt contributed to their interest and success in the sciences up to that point, and the barriers they perceived they needed to overcome in continuing their studies. Eighty-six women completed a survey containing seven open-ended questions. The data were grouped into five subheadings: longevity of science interest and influential people, career plans and mentors, challenges and rewards of a science career, factors affecting educational decisions, and needs for additional information. The findings of this study may be used to provide insights to science educators at all levels and to career counselors regarding what interventions might be developed and implemented to increase the participation of women in science careers. Contains 24 references. (DDR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 418 857

Factors Affecting Undergraduate Women's Consideration of Graduate Study in Science

by

Patricia D. Morrell
University of Portland
School of Education
5000 N. Willamette Blvd.
Portland, Oregon 97203
503-978-8013
morrell@up.edu

and

Gail Glick Andrews
Oregon State University
Department of Bioresources Engineering
Corvallis, Oregon 97330
541-737-6294
glickg@ucs.orst.edu

A paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Diego, California, April, 1998.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

P. Morrell

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

SP030331

Factors Affecting Undergraduate Women's Consideration of Graduate Study in Science

Since the initiation of education equity legislation over two decades ago, progress has been made in increasing the number of women pursuing and succeeding in science careers. High school students' attitudes toward the roles of men and women in science have changed (Physics Today, 1976), and gender differences in attitudes toward science seem to be on the wane (Morrell & Lederman, 1992). High school teachers and counselors have become more responsive in their roles in encouraging females to enter the science profession (Seymour, 1992), and an increasing number of methods courses for pre-service science teachers have an equity-based component.

With all these attempts to equalize the genders in the sciences, however, the number of females entering the profession is still quite below that of males (Brush, 1991). Less women than men receive undergraduate degrees in the sciences, and a smaller fraction of those women go on to study for advanced degrees (Tobias, 1992; White, 1992). Despite the fact that overt discrimination has declined, female science students and professionals are faced with subtle psychological and social barriers which can lead to attrition of women from the sciences (Gibbons, 1992a; Zukerman, Cole & Bruer, 1991). Women still feel science is an "old-boy network," and suffer from a lack of mentors (Didion, 1992; Gibbons, 1992b; Seymour, 1992). Compared to males, women appear to be more discouraged by grades and a lack of emotional support (Seymour, 1992; Sloat, 1990). Once they are established in the field, women still tend to earn less than their males counterparts. In academia, male science faculty members are paid an average of 8-10% more than female science faculty members of the same rank (Magner, 1997).

Equitable science education is considered a requisite for a scientifically literate society (National Research Council, 1996). In retrospect, although the subject has received great attention, gender equity in the sciences is still a long way from being a reality. How can we effectively increase and retain the number of females considering a career in the sciences?

The purpose of this study was to focus on female undergraduate students who were considering graduate study in the sciences to attempt to identify their critical attributes and concerns. Of particular interest were the factors the women felt contributed to their interest and success in the sciences to this point and the barriers they perceived they needed to overcome in continuing their studies. The information from this study may be used to provide insights to science educators in both lower and higher education and to career counselors as to what interventions might be developed and implemented to increase the participation of women in science careers.

Method

A survey containing seven open-ended questions was developed to examine factors that may affect an undergraduate woman's decision to pursue graduate study in science. The formation of the questions was guided by social cognitive theory (Bandura, 1977). This theory holds that one's interest in a career, particularly one that is stereotypically gender oriented as science, is a psychosocial phenomenon. There is a reciprocal, rather than unidirectional relationship between gender conception and sex-typed learning, and the social determinants of gender roles must receive considerable attention (Bandura, 1977, p. 98). Accordingly, the questionnaire asked about perceived rewards and challenges of a scientific career, both in general and for women in particular; influential individuals and events contributing to an interest in science; career plans and people with whom those plans were discussed; and personal factors.

The instrument was reviewed by a male science education professor, a female physics professor, and three female undergraduate science students to assist in ensuring the questionnaire had face validity and would solicit the information we were hoping to gain.

The sample for the study, of necessity, was biased. The survey and a consent form were sent to 120 undergraduate women who had been invited to attend a Symposium on Graduate School in Science for Undergraduate Women. All these women were enrolled in four-year college and universities in the Pacific Northwest and were nominated to attend the Symposium based on grade point average, junior or senior standing, and area of interest for graduate study. It was assumed the participants would be representative of the female students most likely to continue with advanced studies in the sciences from this Region. In all, 98 women responded: 86 (88%) returned completed surveys and 12 (12%) indicated they did not wish to participate in the research, for a total response rate of 82% (98/120).

The completed survey forms were read independently by the two authors, and possible patterns were identified using the coding category technique described by Bogdan and Biklen (1982). On a second read-through, information which would either support or negate the postulated patterns was noted. The two researchers then met to compare and negotiate their findings. In all instances, the researchers were in agreement.

Results and Discussion

The data were grouped into five subheadings for ease in reporting and discussing the results: Longevity of Science Interest and Influential People, Career Plans and Mentors, Challenges and Rewards of a Science Career, Factors Affecting Educational Decisions, and Needs for Additional Information. When possible and appropriate, percentages of individuals fitting particular

categories are provided. It should be noted that these are rough estimates as boundaries of categories may sometimes be gray areas and some women may not have responded to each question. It must also be stressed that these data were not gathered in a manor which lend themselves to quantitative analysis, and any attempt to do so would be invalid.

Longevity of Science Interest and Influential People

When the women developed an interest in science seemed to be evenly divided among three areas: early in life, during high school, while in college. A third of the respondents indicated they had a life-long interest in science. It would appear that their home lives had a greater influence on their attitudes than their early school experiences. These women noted they had a "love" of the outdoors, recalled visiting museums and aquariums, watched nature shows on television, and read science-related books and magazines. The feeling was their interest originated in science-related subject matter versus process. Only a small number indicated performing backyard and in-home science experiments. Several (six) stated they were influenced to study science because of their participation in school science fairs, and an equally small number (eight) felt they had been motivated to pursue science because of a particular elementary or junior high school teacher or early school-related science experience.

For these women who developed an early interest in science, "father" is most frequently mentioned as being influential, followed by parents, mother, and a scattering of other family members. In one case, it was indicated that both parents had scientific careers, followed by a comment that her father influenced her greatly with no further mention of her mother's influence. The father's influence seems to fall into two categories: (a) providing stimulating events (nature hikes, museum trips); and (b) acting as an intellectual role model (source of answers, science-related career).

Interestingly, a study by Romano (1996) on women student leaders showed that these women were greatly influenced by strong female role models, particularly their mothers or grandmothers. No woman in our study mentioned a grandmother's or sister's influence, while both grandfather and brother were noted. For these women choosing to major in science, the influence of a male was certainly predominate. While our questionnaire did not ask for information on the respondents' extra-curricular activities/positions, the contrast of influential role models is interesting.

Another third of the women reported they decided to study science sometime during their secondary school education. Science and mathematics teachers were very influential for this group. It appears that the quality of interactions between the teacher and the student can have a strong impact on the student's interest in the subject matter. In most cases, the comments revolved around the teacher making the class interesting or instilling encouragement and confidence in the student's belief in her abilities. Advice from respected teachers regarding careers and future academics was also an important factor for some. In addition to school science classes, participating in science camps and the Science Olympiad had a positive impact on some of the girls' decisions to further pursue scientific studies.

The final third of the respondents did not decide to seriously study science until after completing high school. Reasons for this decision were evenly divided among: having a general interest in science; being influenced by a college science class; and receiving motivating advice from a particular college faculty member. In addition, a few mentioned they decided to study science because they saw it as a challenge, and a handful indicated they chose science because it offered career possibilities. Most of the women who decided to study science

after high school tended to be returning students who saw scientific study as a way to better themselves economically or to provide fulfilling employment.

The finding that women were equally likely to get interested in science at anytime during their three main levels of education (elementary, secondary, higher education), was surprising when one considers the findings of attitude studies done with K-12 students. Generally, students who have a positive attitude toward science in high school tended to be strongly influenced by their families (camping trips, experiments at home, television shows, books, etc.) (Morrell & Lederman, 1992; Ebenezer & Zoller, 1993).

It is heartening to find that women can be influenced to pursue a career in the sciences at various points in their educational studies. Farmer, et al. (1995) reported that women tend to firm their career plans after high school. Although two-thirds of the women in our study reported a bend toward a science career before completing high school, one-third was influenced in college and the specifics of that "bend" for all were certainly cultivated in college. This has serious implications for teachers at all educational levels, because it shows that females can be seriously influenced throughout their schooling and lends credence to interventions that may not be implemented until high school or college years.

Career Advice and Mentors

Respondents were asked to list the people with whom they had discussed their career choices, both for formal advice and in informal conversation, and to indicate the type of feed-back they had received. The majority of the respondents reported discussing their plans with some combination of family, friends, faculty, and other in the professional field of interest.

Over 75% of the women said they had discussed their career plans with family or friends and generally received encouragement in pursuing their goals.

Mostly, responses were general and supportive in nature ("I'm behind you in whatever you pursue.") rather than directional or advising in content. The overriding theme is that family and friends typically offered very little guidance because they are generally unfamiliar with scientific career paths. Their approval and support, however, was a strong commonality seen among these women.

Approximately 80% of the participants discussed their career interests with a college advisor, professor, or an employer. For the most part, they received encouragement but generally very little guidance. College advisors tended to provide guidance on course work needed to complete the current degree with no real help in deciding on plans beyond the bachelor's degree. Some professors' advice tended to be narrow, with the women feeling the professors were herding the women into the field in which the professor was involved. Other faculties' advice were viewed as too philosophical with little concrete guidance ("make sure this is what you really want to do," "don't choose till you get to graduate school"). The women commented that, while supportive comments were welcomed, they needed more than just positive feedback on their own career ideas. Less than a fourth felt they had received any concrete guidance from anyone regarding future educational and/or career plans in science.

On a more promising note, less than 12% of the women mentioned receiving any discouraging feed-back regarding their career plans. Some family members had concerns about finances, future employment, and parenting duties. Although no one noted receiving overt discouragement because of their gender, many were told by advisors that they "wouldn't be able to do this or that." Career counselors were quoted as "not (being) very supportive or encouraging about scientific careers" or told the field of study was inappropriate ("Physics is a dying field."). Friends warned of burnout and frustration. Virtually all women,

however, did receive positive feedback from someone with whom they spoke! No one noted receiving overt discouragement because of their gender, i.e. science is a field for males. The overall picture painted by the respondents, though, is that these women are not receiving specific information they feel they need to make informed decisions about graduate school or career options.

Challenges and Rewards of a Science Career

When discussing their career plans, the responses ranged from "no idea" to descriptions of proposed graduate research projects and the ideal job that would follow. Responses did not fall into clear categories, but represented a broad range of possibilities.

The respondents appeared to have a fairly realistic view of a scientific *research* career based on their descriptions of the rewards and challenges it offers. The most commonly mentioned concerns were finding employment and receiving funding for research. Also identified as a challenge was keeping current in the field. The main rewards were bettering society and the excitement/satisfaction from working in an intellectually stimulating position. Interestingly, many of the women in describing their career goals emphasized the desire to be a professor in or affiliated with an institution of higher education. In describing the rewards and challenges of a scientific career, however, these women did not describe any aspects associated with teaching, almost as if teaching were not a part of an academic science career.

The participants did not see many differences between men and women when evaluating a science career. All but one, however, listed several special challenges they perceived existed for women in science careers. The two major ones were overcoming the attitudes associated with being a woman in a male dominated field (stereotyping, discrimination, need to "outcompete" males, and the like) and dealing with the difficulties of balancing a family with a career. The

main rewards the participants perceived they would receive from choosing to work in a science field were being successful at something few women have done ("making it in a man's world") and being able to serve as a mentor or role model for other women and girls.

A concern that a few women noted is one that has previously been documented in the literature (Seymour, 1992). Women tend to learn differently than males, and women require more of a support system than men.

"Another challenge that women face is effectively communicating with male peers and supervisors. Men have a different style of communicating than women do."

"A hint of encouragement by any of them (my professors) does go a long way."

"(A major challenge is) getting through those first 2 years of undergraduate work with enough self-esteem to continue."

Factors Affecting Educational Decisions

When asked what current factors in their lives were affecting their decision to pursue an advanced degree in science, the participants noted both positive and negative influences. Among the positives were the desire to continue their education and learning, personal satisfaction derived from working in the sciences, and the feeling that employment prospects were better in this area than others. The factors that were making the women consider not continuing their education were the lack of money needed for graduate school, needing more time to spend nurturing personal relationships with partners and/or families, and desiring to take a break from school before continuing. Some were uncertain as to what area(s) to concentrate in for graduate studies and which areas would be most promising in terms of future employment possibilities. Many of these concerns could have easily been addressed via proper advising.

As noted earlier, college advisors were most often concerned with giving students advice solely on completing their undergraduate degree.

Needs for Additional Information

When asked specifically what information would help the women in making a career decision or pursuing their goals, responses could be grouped into three main areas. Virtually every respondent had one or more questions concerning graduate school. The questions were rather basic and revolved around how to apply, what requirements and expectations are, financial aid availability, and which schools were better for what areas of science. More than half noted they really had no notion of what career options would be available to them, especially outside academia. For both of these areas, advisors should have been able to provide this information or direct the women to other campus resources. It seems that the respondents did not feel comfortable talking about their career questions with their advisors or did not feel that they should. For instance:

"My advisor basically agrees with whatever plan I suggest to him."

"There is some deafness among a few faculty men when women speak, I think. It seems assumed that we tend to be a bit flaky in our resolve."

About a third noted they wish they had had a women science mentor. They wanted someone to talk to who would understand their concerns first-hand, and wanted to hear from women professionals about their choices, the problems they encountered, how it affected their lifestyles, and their solutions to concerns:

"For women, as they are underrepresented in science, I think that there are fewer role models. I feel that I need to identify with someone who may be going through a lifestyle that I am anticipating."

These findings are similar to those of other studies. Garelick (1980) and Strauss (1978) both noted women's concerns with balancing a family and a

career. The need for female mentors has also been well documented (Didion, 1993; Gibbons, 1992b, Johnsrud, 1995; Seymour, 1992; among others). This seems to be circular in nature: women shy away from science because of a lack of female mentors which leads to a continuing shortfall in the supply of female mentors.

Conclusions and Implications

So, if one were to make a composite of the "typical" female choosing to pursue a graduate study in science, what would she look like? She would be someone who either always was fascinated with science (mostly due to family activities) or was strongly influenced by a high school teacher/class or college professor/course. She is uncertain of her ability to succeed in a male-dominated profession, and craves approval and support. Most of her networking is done with family and friends, who offer her the emotional assurance she needs. She lacks a strong relationship with a knowledgeable mentor, however, and has many basic questions about graduate school in general (applying, finances, expectations) and more specifics such as to which schools she should apply, on what she should focus her studies, and what career opportunities will be available to her upon completion. Although lacking some of this baseline information, she is conscious of the main problems facing a research scientist and the demands of the profession, both academically and socially.

In retrospect, the findings of this study mirror those of the 1970's and 1980's (Alden & Seiferth, 1981; Strauss, 1978; Button & Brown, 1980). Although some positive movement has been made in terms of numbers, most females still do not feel "welcome" entering a science field and have few established members helping them to make this transition. Let us re-examine what the women respondents in this study perceive as the positive factors influencing their

choice to study science and the hindrances to their meeting their educational and career goals; and what these suggest to educators:

1. family influences - Because a third of the females cited science-related family activities having a positive influence on them, these should be fostered as much as possible. Elementary schools may be the best agent. Family science nights, school-sponsored science fairs, and take-home family science activities may all be useful in getting parents and students working together.

2. high school teachers/courses - Gender equity has not yet been achieved in most high school classrooms. Bailey, et al. (1997) reported that even though preservice teachers may be exposed to equity-based science methods, their cooperating teachers are not; and a reversal to traditional methods by the preservice teachers during their field experiences is not uncommon. Seymour (1992) notes that girls that are identified and strongly encouraged by high school teachers and counselors are actually at a disadvantage when they advance to college. The affective relationships that were developed in the secondary school are most often replaced by impersonal relationships in higher education, and the females are not prepared for this lack of socialization. Though the outlook seems bleak, it must be noted that many women in this study felt their high school experiences led them to consider studying science. We must continue to work on improving pedagogical techniques at this level so females begin to develop an intrinsic sense of self-worth and develop confidence in their abilities to succeed in science. While hard data are not yet available, it would seem that the current trend toward constructivist teaching practices and inquiry-based methodologies may be helpful in recruiting females into the sciences.

3. college teachers/courses - A large proportion of the women in this study who are considering graduate school in science did not come to that decision until leaving high school. This suggests there is an opportunity to recruit talented

women into the sciences at the undergraduate level. The women in this study expressed questions about their academic adequacies and their need for a supportive network to help them in this male-dominated field. As with lower education, a change in teaching styles in higher education may have a positive impact. Many federally sponsored programs are underway to encourage constructivist teaching styles in undergraduate science programs. Though the projects are still ongoing (e.g.. OCEPT in Oregon, IISTEP in Colorado), being exposed to science courses not taught in the more traditional lecture method may have a positive effect on recruiting and retaining women.

4. mentors - Although the need for women to have mentors has been identified decades earlier, this need is still not being met for most female undergraduates. As noted earlier, the problem tends to be cyclical. Johnsrud (1995) reports on studies that suggest male mentors may equal or surpass female mentors for women depending on their style of advising. Advisors need to reexamine how they interact with their students to see if the students' interpersonal needs can be better met. College faculty also must be aware of the needs of undergraduates (males and females), and provide advice that goes beyond completing the bachelors degree. These students need information about career possibilities and basic knowledge concerning graduate school requirements and application processes. Females also need to feel encouraged and welcomed into the field. Informal interactions should be frequent and positive.

The encouraging finding is that women do not have to be interested in pursuing a career in science from a young age. A sizable proportion of the women in this study who are considering graduate school in science did not come to that decision until leaving high school. This suggests there is an opportunity to attract talented women into the sciences at the undergraduate level. The availability of an influential individual such as an instructor or

academic advisor appears to be the most viable key. It also suggests that the current trend of implementing intervention strategies in higher education should work in recruiting and retaining women in the science fields.

This study was funded in part by NSF Grant HRD9353787 to Oregon State University for the Symposium on Graduate Study in Science for Undergraduate Women.

References

Alden, E.F., & Seiferth, B.B. (1981). Women in science and technology. *High School Journal, 64*(8), 322-325.

Bailey, B.L., Scantlebury, K., & Letts, W.J. (1997). It's not my style: using disclaimers to ignore gender issues in science. *Journal of Teacher Education, 48*(1), 29-36.

Bandura, A. (1977). *Sociological foundations of thought and action: A social cognitive theory.*

Bogdan, R.C., & Biklen, S.K. (1981). *Qualitative research for education: An introduction to theory and methods.* Boston, MA: Allyn and Bacon, Inc.

Brush, S.G. (1991). Women in science and engineering. *American Scientist, 79,* 404.

Button, L., & Brown, R.A. (1980). Women in Science. *School Science and Mathematics, 80*(3), 206-210.

Didion, C.J. (1993). Attracting graduate and undergraduate women as science majors. *Journal of College Science Teaching, 73*(3), 141-144.

Ebenezer, J.V., & Zoller, U. (1993). Grade 10 students' perceptions of and attitudes toward science teaching and social science. *Journal of Research in Science Teaching, 30*(2), 175-186.

Farmer, H., Wardrop, J.L., Anderson, M.Z., & Risinger, R. (1995). Women's career choices: Focus on science, math, and technology careers. *Journal of Counseling Psychology, 42*(2), 155-170.

Garelick, J. (1980). Academia's Reluctant heroines. *Change, 12(1), 17-20.*

Gibbons, A. (1992a). Key issue: Two-career scientist marriage. *Science, 255*(5050).

Gibbons, A. (1992b). Key issue: Mentoring. *Science, 255*(5050).

Johnsrud, L.K. (1995). Women in graduate education: Reviewing the past, looking to the future. *New Directions for Student Services, Winter,* (72), 69-80.

Magner, D.K. (1997). Increases in faculty salaries fail to keep pace with inflation. Chronicle of Higher Education, 43*(43), A8-A9.*

Morrell, P.D., & Lederman, N.G. (1992). *What students say about classroom science.* A paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Atlanta, Georgia.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Physics Today. (1976). What barriers impede women's science careers? *Physics Today, 29*(8), 63.

Romano, C.R. (1996). A qualitative study of women student leaders. *Journal of College Student Development, 37*(6), 676-83.

Seymour, E. (1992). Undergraduate problems with teaching and advising in SME majors--explaining gender differences in attrition rates. *Journal of College Science Teaching, 21*(2), 276-278.

Sloat, B.R. (1990). Perspectives on women and the sciences. *LSAmagazine, 13*(2), 13-17. (ERIC Document Reproduction Services No. ED 331 704).

Strauss, M.J.B. (1978). Wanted: More women in science. *American Biology Teacher, 40*(3), 181-185+.

Tobias, S. (1992). Women in science--women and science. *Journal of College Science Teaching, 21*, 276-278.

White, P.E. (1992). *Women and minorities in science and engineering: An update.* (Report No. 92-303). Washington, DC: National Science Foundation.

Zuckerman, H., Cole, J.R., & Bruer, J.T. (1991). *The outer circle: Women in the scientific community.* New York: W.W. Norton & Co.